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Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Amendment of Part 90	)	
of the Commission's Rules	)	PR Docket No. 93-61
to Adopt Regulations	)	
for Automatic Vehicle	)	
Monitoring Systems	)	

COMMENTS OF PINPOINT COMMUNICATIONS, INC. ON EX PARTE PRESENTATIONS

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To: The Commission

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ON EX PARTE PRESENTATIONS

Pinpoint Communications, Inc. ("Pinpoint"), by its attorneys, hereby submits these comments in response to the Commission's Public Notice dated February 9, 1994, in the above-captioned docket.[1]

SUMMARY

As explained in the Notice, the Commission specifically seeks comments on *ex parte* presentations recently filed by certain proponents of wide-area automatic vehicle monitoring ("AVM") operation in the 902-928 MHz band: PacTel Teletrac ("PacTel")[2], MobileVision,[3] and Southwestern Bell Mobile Systems ("Southwestern

[1] *Regulations for Automatic Vehicle Monitoring Systems,* Public Notice, DA 94-129, 59 Fed. Reg. 7239 (Feb. 15, 1994).

[2] Letter from John R. Lister, President, PacTel Teletrac, to Ralph A. Haller, Chief, Private Radio Bureau dated January 26, 1994 ("*PacTel ex parte*").

Bell").[4] These filings, to the extent they differ from these parties' comments and reply comments submitted in this proceeding last summer, actually provide general support for some of the positions taken by Pinpoint in its Comments and Reply Comments in this proceeding.[5] In those filings, Pinpoint set forth its own band plan proposal characterized by sharing throughout the entire 902-928 MHz band by wide-area and local-area AVM systems.[6]

As discussed in detail herein, the *PacTel ex parte* represents an extreme departure from PacTel's earlier band plan position. Specifically, PacTel for the first time confirms the feasibility of sharing by wide-area AVM systems in the 902-928 MHz band. As a result, PacTel proposes a radically different band plan than that put forth in its comments in this docket. While Pinpoint has some reservations about PacTel's newly proposed bandplan, as explained herein, the *PacTel ex parte* introduces

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[3](...continued)

[3] Letter from John J. McDonnell and Marnie K. Sarver, Counsel for MobileVision, L.P., to Ralph A. Haller, dated February 1, 1994 (*"MobileVision ex parte"*).

[4] Letter from Robert L. Hoggarth, Counsel for Southwestern Bell, to William F. Caton, Acting Secretary, FCC, dated February 2, 1994 *("Southwestern Bell ex parte").* Attached to the *Southwestern Bell ex parte* is a report entitled "Capacity and Interference Resistance of Spread-Spectrum Automatic Vehicle Monitoring Systems in the 902-928 MHz ISM Band" prepared for Southwestern Bell by the Mobile and Portable Radio Research Group, Virginia Tech, and dated January 14, 1994 *("Southwestern Bell ex parte Report').*

[5] comments of Pinpoint Communications, Inc. PR Docket No. 9361 (filed June 29, 1993) ("Pinpoint Comments"); Reply Comments of Pinpoint Communications, Inc., PR Docket 93-61 (filed July 29, 1993, corrected Aug. 3, 1993) ("Pinpoint Reply Comments").

[6] "Wide-area" AVM systems employ a technology permitting the automatic location of a vehicle using an infrastructure wherein the range of fixed sites is on the order of several miles or more. While a few direction-finding location systems are employed elsewhere, all wide-area vehicular system designs of which Pinpoint is aware employ hyperbolic multilateration techniques. "Local-area" area systems, in contrast, are those that operate over ranges of several hundred feet or leas, and are typified by the reader/tag arrangements described *in the NPRM. See Regulations for Automatic Vehicle Monitoring Systems*, Notice of Proposed Rulemaking, 8 FCC Rcd 2502, 2502-3, 2504 (1993) (*"NPRM"*).

elements worth considering. With certain modifications, these elements could serve to accommodate the design and implementation flexibility needed by wide-area AVM operators and others users of this band, and thus the rapidly growing needs of the American public. Therefore, Pinpoint would have no objection if the Commission were to set aside a sub-band of about 10 MHz bandwidth for wide-area AVM systems on a shared basis subject to the following sharing conditions, which are amplified in Section V herein:

- The 902-912 MHz sub-band would be set aside for wide-area AVM systems on a primary basis.[7]

  The 902.00 - 902.25 MHz sub-band could be used for emergency voice communications on 12.5 or 25 kHz channels, preferably available for use by all wide-area AVM systems in the 902-928 MHz band on a trunked-radio basis.

  The 902.25 - 902.50 MHz sub-band could be set-aside for dedicated narrowband forward links or timing/system control channels.

  The 902.5 - 912.0 MHz sub-band would be shared by all financially and technically qualified operators applying in the filing window for each wide-area AVM market, pursuant to negotiated sharing arrangements approved by the FCC.

  New local-area AVM systems could not center their illuminating signals in this sub-band, but could attenuate their signals' side-

[7] PacTel proposes to set aside the 902-912 MHz band for wide-area systems and the 912-928 MHz band for local-area systems. *PacTel ex parte*, attachment *at* (1). For purposes of discussion of PacTel's proposal, Pinpoint will refer in these comments to 912 MHz as the boundary between two such segregated sub-bands. However, Pinpoint recognizes that if the Commission adopts a segregated band plan, it may determine that a boundary other than 912 MHz is in the public interest. Provided that wide-area systems have access to 16 MHz of continuous spectrum, which could include access on co-primary basis with local-area systems, as described below, Pinpoint has no objection to precisely where that boundary is in fact located. Pinpoint also has no objection to operation by local-area systems in any "wide-area band" on a secondary basis.

bands in the frequencies below 912 MHz subject to strict power limits.

Existing local-area systems should be permitted to remain in the 902-912 MHz band for a specified period and then only be required to move when they are causing interference to a wide-area system that cannot otherwise be resolved.

- The 912-928 MHz band should be available for co-primary sharing pursuant to Section 90.173 of the FCC's rules by wide-area and local-area AVM systems. If more than one qualified wide-area AVM system applicant desired to operate in this spectrum, all such systems would do so on a shared basis under procedures also governing use of the 902.5 - 912.0 MHz sub-band.

Pinpoint agrees with Southwestern Bell that the appropriate market sizes for wide-area licensing are Metropolitan Statistical Areas ("MSAs") and Rural Service Areas ("RSAs"). Among other things, MSAs and RSAs are preferable to the much-larger Basic Trading Areas ("BTAs") for wide-area systems because the MSA/RSA divisions are perfectly congruent with those employed in cellular licensing. Cellular service, like AVM, is characterized by vehicular applications and there may be complementary uses of the two services. Use of MSAs and RSAs will also better facilitate the economic deployment of AVM in smaller markets.

Pinpoint disagrees vigorously with the continued objections to the feasibility of time sharing raised by Southwestern Bell. Southwestern Bell's analysis of AVM systems reflects total misunderstanding of the key elements in the design of Pinpoint's system, these being the absence of any separate forward link, and the integration of vehicle location and data messaging functions simultaneously in a single signal. While these features enhance Pinpoint's capability to share the spectrum, all wide-area

systems are suited to time sharing, particularly because vehicle location typically involves some sort of time-sharing scheme among mobiles within an individual system.

Southwestern Bell's suggestion that wide-area spectrum should be split into four 4 MHz assignments would rob the public of the tremendous capacity gains and efficient use of the spectrum resource achievable by wider-bandwidth operation. While acknowledging the more-than-linear increase in vehicle location capacity as bandwidth increases, Southwestern Bell suggests that throughput experiences a gain merely proportional to bandwidth increases. However, in practical designs and applications, the maximum data throughput is not governed by theoretical limits but by design trade-offs and the non-ideal characteristics of the mobile environment. Because the available design trade-off options grow rapidly with increasing occupied bandwidth, "design" throughput will in fact increase supra-linearly with bandwidth without exceeding the theoretical limits. Therefore, the Commission should not artificially restrict permissible bandwidth in the 902-928 MHz band.

Finally, Pinpoint disagrees with suggestions, principally made by MobileVision, that more accommodation to voice communication is needed in the 902-928 MHz band. Rather, voice should play a limited and auxiliary role to AVM. The Commission has already set aside numerous bands and established services that can be used for voice in conjunction with AVM -- cellular, SMRS, PCS, trunked private band mobile radio -- while the 902-928 MHz band is the only one with sufficient bandwidth for high-speed radiolocation systems. Therefore, Pinpoint proposes that if the Commission authorizes

voice, only a 250 kHz sub-band should be set aside for that purpose in this band and should be restricted to emergency uses.

I. INTRODUCTION

In its Comments, Pinpoint advocated sharing of the AVM band (902-928 MHz) among all interested and *qualified* wide-area AVM system applicants. Additionally, the entire band would be shared between wide-area operators and local-area systems.* In recognition of (a) the systems already deployed in a few markets, (b) the desire of some designers to deploy low-powered wide-area AVM systems, and (c) the reservations expressed by some other wide-area AVM system designers about whether sharing between wide-area and local-area AVM systems is practicable, Pinpoint suggested the creation of two 4 MHz zones (at 906-910 and 920-924 MHz) in which local-area systems would be required to restrict their maximum effective radiated power to levels over 20 dB lower than they are otherwise permitted in the band.' The bandwidth of these "quiet" zones was determined by the requirements for 4 MHz of contiguous spectrum indicated in the other wide-area AVM designers' filings with the FCC.[10]

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[8] Pinpoint Comments at 32-33.

[9] *Id.* at 33-34. Thus, the two 4 MHz zones would experience lower noise levels from local-area systems.

[10] See Comments of MobileVision, L.P., PR Docket No. 93-61 at 30-31 (filed June 29, 1993); Comments of North American Teletrac and Location Technologies, Inc., PR Docket No. 93-61 at 24 n.27 (filed June 29, 1993); Comments of Southwestern Bell Mobile Systems, PR Docket No. 9361 at 8 (filed June 29, 1993) ("Comments of Southwestern Bell").

Although Pinpoint does not itself require spectrum separate from its wideband channel for forward links and control transmissions, the band plan proposal contained in its original comments would provide for separate narrowband frequencies at the extreme upper and lower edges of the 902-928 MHz band for such purposes." In addition, recognizing the potential for the noise floor to increase in the 902-928 MHz band over time, Pinpoint proposed power level limits for wide-area systems throughout the 902-928 MHz band that would allow operators to balance their own power levels against the anticipated increases in the noise floor for the foreseeable future.[12]

In the record developed in this proceeding prior to the *PacTel ex parte*, a few wide-area system proponents challenged Pinpoint's assertion that time sharing was feasible. This effort was spearheaded by PacTel. PacTel, in its *ex parte, has* prudently changed its original position. Specifically, PacTel now recognizes the feasibility of both time sharing and limited co-channel simultaneous operation by wide-area systems. Indeed, PacTel now makes time sharing an essential part of its band plan proposal. While PacTel apparently contemplates time sharing limited to high-powered "housekeeping" signalling, its proposal clarifies that time sharing in a wide-area AVM sub-band is feasible.[13] PacTel still, however, proposes arbitrarily to limit

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[11] Pinpoint Comments at 22.

[12] See Pinpoint Reply Comments, Appendix B at 18-20 ("Technical Appendix") (discussions of managing potential interfereace through power level management). While greater than the power levels proposed in the *NPRM*, the Pinpoint-proposed effective radiated power limits are still significantly lower than the effective radiated powers possible under the current AVM rules.

[13] Under PacTel's scheme, the mobiles apparently would operate on a code division multiple access ("CDMA") basis in a shared 6.5 MHz wide sub-band. As discussed *infra*, Piapoint submits that the (continued...)

the number of wide-area AVM licensees to two per market. As amplified below, PacTel fails to provide adequate reasons for this limitation.[14]

In contrast, the ***Southwestern Bell ex parte Report*** almost disdainfully dismisses time sharing. Notably, the ***Report*** was completed prior to the submission of PacTel's new band plan proposal. The ***Report,*** however, recognizes that the ***radiolocation capacity*** of AVM systems increases more rapidly than changes in bandwidth. Accordingly, a wider bandwidth time shared by several systems would have greater vehicle location capacity than the same spectrum divided into small sub-bands and assigned on an exclusive basis to those same systems. Although the ***Southwestern Bell ex parte Report*** tries to downplay the importance of its observation, by arguing that the increase in ***data throughput*** is only proportional to bandwidth, for all practical purposes occupied bandwidth for vehicle location systems is determined principally by the radiolocation requirements, not those of the incidental data messaging. Indeed, all parties other than Pinpoint use a separate channel or "forward link" for control and data than that used for radiolocation, rendering Southwestern Bell's argument about

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[13](...continued)
public interest would be better served if mobile operation was also subject to time sharing, which would not foreclose the use of CDMA *to advantage within time increments* by interested system designers.

[14] In an *ex parte* filing made in October 1993, Southwestern Bell underscored the advantages for the development of competition if more than two wide-area systems are allowed to market. Supplement to Reply Comments of Southwestern Bell Mobile Systems, Inc., PR Docket No. 93-61 (filed Oct. 15, 1993) ("Competition in Wideband Location Monitoring Services," by Leland L. Johnson) ("Southwestern Bell Supplement"). This has been Pinpoint's position as well. Pinpoint Reply Comments at 24-31; id., Appendix C, "Analysis of the Economics of Channel Exclusivity for Wide-Area Location Monitoring Systems" ("Economic Analysis"). Even more importantly, the Commission, in its *NPRM*, proposed sharing by multiple wide-ares systems, if feasible, precisely because the public interest is served if the band plan maximizes the opportunities for competition by multiple systems, leading to new technological advances and more robust systems. 8 FCC Rcd at 2506.

radiolocation throughput largely irrelevant. Moreover, Pinpoint submits that an allocation for AVM should be optimized for radiolocation, not necessarily for data communications. System data throughput is a more closely a function of an AVM system's design and is less governed by theoretical predictions of data rate versus bandwidth.[15] Accordingly, the *Southwestern* Bell *ex* parte *Report* actually provides support for Pinpoint's position that it would be in the public interest for wide-area systems to have access to as much bandwidth as possible on a time shared basis.[16]

II. PACTEL'SEX *PARTE* PRESENTATION CLARIFIES THE DISPUTE ABOUT TIME SHARING: IT CAN BE DONE AND IS PRACTICAL

Much of the dispute among wide-area AVM systems in this proceeding has centered on the feasibility of sharing. The Commission in its *NPRM* had proposed sharing by wide-area systems, unless it could be demonstrated that sharing at this time is infeasible.[17] Heretofore, no party, including Pinpoint, has argued that multiple wide-area systems could share the same spectrum while operating simultaneously. PacTel (formerly), MobileVision and Southwestern Bell argued for exclusive licensing,

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[15] In other words, the level of throughput results from system design choices in addition to bandwidth. For example, mobile operation at 900 MHz occurs with severe multipath distortion. Further constraints may be introduced by the choice of spread spectrum options. Thus, when comparing one system to another, wideband data throughput in conjunction with radiolocation throughput, in fact, may increase more rapidly with respect to bandwidth than "theoretically" predicted by Shannon's Theorem, because practical "design" throughputs are still less than theoretical limits.

[16] Southwestern Bell's *ex parte indicates that* it completely misunderstands (or is ignorant of), the technical nature of Pinpoint's integrated solution to location, control, and messaging. See pages 20-21 *infra*. As a result, *the Southwestern Bell a parte Report* derives unwarranted general conclusions about what is and is not possible for wide-area systems in the 902-928 MHz band.

[17] *NPRM*, 8 F.C.C. Rcd at 2505-06.

maintaining that time sharing was infeasible. Only Pinpoint has consistently acknowledged that (time) sharing is feasible and devised a band plan to accommodate that capability.

As a result of the *PacTel ex parte*, the landscape has changed completely. By proposing to time share for purposes of "housekeeping," PacTel evidences that time sharing among multiple wide-area systems is feasible. Specifically, PacTel proposes that sharers of the same spectrum use the Global Positioning Satellite system ("GPS") as a common timing standard.[18] Thus, in principle, PacTel now agrees with Pinpoint that some form of time sharing is feasible.

As discussed below, the remaining proponents of exclusivity, MobileVision and Southwestern Bell have not rebutted sharing as a feasible approach to operation by multiple entities. However, PacTel, despite its admission, would still artificially try to limit competition to two licensees per market, a position which Pinpoint submits cannot be justified for the reasons PacTel has offered.

A. Southwestern Bell and MobileVision Fail to Offer Satisfactory Reasons Why Time sharing Is Not Feasible

With only two sentences of discussion, Southwestern Bell casually concludes that time sharing is not feasible.[19] This is reminiscent of its brief discussion of the issue in their comments and reply comments in this proceeding. That Southwestern

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[18] *PacTel ex parte,* attachment at (3). In its Comments, Pinpoint explained how GPS could serve as an acceptable time control standard in a sharing arrangement. See Pinpoint Comments at 17.

[19] *Southwestern Bell ex parte Report* at 6.

Bell has never truly engaged the issue is not surprising, given its ostensible misunderstanding of Pinpoint's AVM system design and, more recently, the authors' of the ***Southwestern Bell ex parte Report*** lack of foreknowledge of **PacTel's** new proposal.

Southwestern Bell briefly offers three reasons for its conclusion that time sharing is unworkable. First, it alleges that the infrastructure required for coordinating individual systems would be unworkable. As Pinpoint has explained in its earlier pleadings, the infrastructure required could be quite simple, requiring only a common time standard and an agreement among licensees in advance how time segments would be sliced for each system's use.[20] The ***PacTel ex parte*** confirms this solution.[21]

Second, Southwestern Bell contends that large amounts of time would be wasted in the "time guard bands" that would be required to prevent interference between "consecutive" sharers of the spectrum. Provided that all systems are coordinating with a common time standard to a certain degree of precision, the size of such guard bands could be rather small. Each system would have to make its own decision about the size of the guard band necessary for its operation to avoid interference with the system

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[20] **Pinpoint Comments at 17. In its Comments, Pinpoint detailed possible procedures by which sharing arrangements could be negotiated among the wide-area systems involved. *Id.* at 35-38.**

[21] ***PacTel** a **parte**,* **attachment** *at (2) (divide* **part of each second into housekeeping time slots and accomplish time synchronization by using the GPS time signal). Pinpoint agrees with PacTel in principle, although sharing plans in each market should be resolved through negotiations among the licensees, rather than by regulatory fiat, except where negotiations become fruitless. While the use of GPS as a time standard might be required by the FCC, the actual division of the time should be left to the licensees, as that solution may vary depending upon the mix of qualified applicants in each market. See Exhibit A attached hereto for an illustration of a hypothetical sharing arrangement.**

following it. Moreover, the percentage of the total time devoted to guard bands would be directly related to the sharing scheme adopted by the licensees in a given market.[22]

Finally, Southwestern Bell argues that time sharing would compromise system design flexibility, which is, according to Southwestern Bell, the "primary advantage of spectrum sharing [through frequency division multiple access.]" As a practical matter, wide-area AVM is well-suited to time sharing because vehicle location by its nature typically involves some sort of time sharing scheme among the mobiles within an individual system. Therefore, there is no foundation for Southwestern Bell's statement, other than perhaps the inconvenience of accommodating requirements not yet present in its existing system. Under Pinpoint's time sharing proposal, the restraints placed upon systems for AVM would be minimal. In exchange for the minimal infrastructure required for time sharing, each of the system designers gains the flexibility to use the part of the band they desire -- while they have access to it in their time slot -- in any

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[22] Given that practical mobile to base-station communication range in the 900 MHz band is less than 20 miles, themaximum amount of "guard band" due to propagation time would be less than about 100 *micro*seconds. Allowing for difference8 in GPS timing over a typical metropolitan area could be an additional 200 microseconds, the maximum amount of guard band needed would only be about 300 microseconds. Thus, only a small fraction of one percent of a "time slice" need be set aside for time guard bands, even if there were ten even "slices" per second of 100 milliseconds each.

If the time intervals are too small, then there may be some unnecessary increase in the total time allocated to guard bands. For two systems, it is difficult to imagine why time intervals of 500 or 250 milliseconds would not be adequate, not to mention one second. In any event, under the sharing procedures suggested by Pinpoint, sharing protocols are worked out by the licensees themselves, so that this issue will likely be resolved in different ways in different markets. Pinpoint recognize8 that some FCC default sharing procedure is desirable, but Pinpoint proposes that defiult intervals should be on the order of several hundred milliseconds, with the total sharing cycle being determined by the number of qualified applicants. See Pinpoint Comments at 37.

way they choose, with little or no interference from other band users.[23] Pinpoint sees little reason why that characteristic alone is not convincing proof that time sharing is feasible from a technical perspective. Moreover, Pinpoint, as described below, does not object to setting aside an appropriate amount of spectrum in the 902-928 MHz band for emergency voice communications to support the AVM function. At bottom, ironically, it is Southwestern Bell that would constrain system flexibility more than PacTel or Pinpoint by reducing the bandwidth available to an AVM operator to 4 MHz," with all of the inherent disadvantages that would follow, such as loss of multipath distortion resolving capability, severe reduction of each network's capacity

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[23] The sharing arrangement negotiated by qualified licensees in a given market might include a combination of time sharing, frequency division, and CDMA. See Pinpoint Comments at 36 n.36 and discussion at pages 28-29, *infra*. *See also* Exhibit A, attached hereto. Indeed, there is no *a priori* reason, under a time sharing scheme as envisioned by Pinpoint, that Southwestern Bell could not negotiate the use of 4 MHz on a continuous basis, giving it whatever flexibility it desires.

[24] *The Southwestern Bell ex parte Report* contends that the choice of bandwidth is influenced by multipath propagation in the mobile environment. As Southwestern Bell recognizes, the resolution of multipath components increases with larger bandwidths. *Southwestern Bell ex parte Report* at 8. However, Southwestern Bell suggests that only modest improvements in resolution will be achieved by increasing the bandwidth from 1 MHz to 10 MHz. *Id*. at 9.

Pinpoint notes that Southwestern Bell's results are based on operations using a CW signal, such as those used by cellular telephone systems, as evidenced by the paper Southwestern Bell cites. Southwestem Bell's conclusions do not necessarily apply to pulse-ranging AVM systems. Because the objective of a high-capacity AVM system is to locate objects using short ranging signal bursts lasting only a matter of a few tens of microseconds, there will not be sufficient sampling of the multipath information (with a timescale of about 1 to 5 microseconds) by the vehicular signal8 (lasting less than about 50 microseconds) to achieve the required accuracy, absent a bandwidth considerably larger than that suggested by Southwestern Bell. Thus Southwestern Bell's analogy to digital cellular is inapposite.

The consequent loss of multipath resolution of systems witb lesser bandwidths introduces very large variances in the estimated time-of-arrival. The variances for wideband estimates in severe multipath conditions, like downtown areas, can be as low as 150 feet with bandwidth in excess of about 16 MHz, good base station placement, and adequate signal levels. If the bandwidth is reduced to 4 MHz, the variances rise to about 1000 feet under otherwise similar conditions.

and reduction of overall band utilization, as Pinpoint has explained on several previous occasions.[25]

MobileVision, in its *ex parte*, responding to PacTel's argument that time sharing is feasible, is aware of the damage that has been done to its position against time sharing. In a desperate effort, MobileVision argues that PacTel's experts, and not PacTel's engineers and system designers, are correct. For reasons that Pinpoint has articulated at length in its Comments and Reply Comments, it is the experts who are not correct.[26]

B. PacTel Offers No Justification for Limiting the Number of Licensees per Market to Two

Having acknowledged the feasibility of time sharing, PacTel now tries to back off all that the feasibility of sharing implies, As Pinpoint urged in its Comments, because sharing, and specifically time sharing, is feasible, the FCC should open a filing window in each market[27] and have each qualified applicant with a proven AVM system meet to negotiate a time-sharing plan with all other such licensees in that

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[25] Pinpoint Comments at 23-26; Pinpoint Reply Comments at 4647. See *also* note 15 *supra* and "Discussion of Factors Affecting Throughput in Wide-Area AVM Systems," prepared by Louis H.M. Jandrell, Vice President of Design and Development, Pinpoint ("Technical Exhibit"), attached hereto as Exhibit B.

[26] Pinpoint Comments at 16-20; Pinpoint Reply Comments at 5-19; id., Technical Appendix at 8-13, 22-32.

[27] *See Section* VI *infra* for discussion of market size for purposes of licensing.

market.[28] The economies of viable competition, not regulatory fiat, would determine how many systems should operate in a given market.[29]

PacTel, however, continues to maintain that only two licensees should be licensed in each market, even under a sharing scheme. As an economic matter and as a matter of FCC pro-competitive policy, that issue has already been convincingly answered in the record. The Commission in its *NPRM* made clear that, under its policies favoring competition and open entry, allowance for more than two competitors in a market would be in the public interest." The only reason that the Commission proposed, in the alternative, that there be two licensees per market was in the event that sharing was not technically feasible, a proposition no longer maintained by PacTel, the former champion of sharing infeasibility.

Further, Pinpoint earlier has addressed in detail the need for the Commission's AVM rules to allow for more than two systems per market if the public were to receive the full benefits of competition, in terms of the number and variety of competitors, declining prices, efficient spectrum use, and technological diversity.[31] Similarly,

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[28] Pinpoint Comments at 37.

[29] *Id.* at *38;* Pinpoint Reply Comments, Economic Analysis at 1-4.

[30] *8* FCC Rcd at 2506.

[31] Pinpoint Reply Comments, Economic Analysis at l-11.

Southwestern Bell has observed in both its comments as well as ***ex parte filings*** that more than two systems are necessary to ensure the competitive provision of AVM.[32]

Indeed, the ***PacTel ex parte*** does not even invoke an economic justification for limiting the number of licensees. Rather, PacTel contends that sharing among more than two entrants is not feasible because of possible collisions among the mobile transmissions of each system as well as with base station housekeeping functions.[33] In a truly time-shared environment, a system's bases and mobiles would only be transmitting (and performing housekeeping functions) in the shared band when they had access to the spectrum according to a previously agreed upon schedule." Even in the event of CDMA co-channel sharing between mobiles of multiple systems, as PacTel appears to propose, the additional degradation over the first co-channel sharer will be small. It is the first co-channel occupant that causes the largest change in degradation.

In addition, PacTel contends that a third system could not have access to the separate narrowband forward links to be used for control functions and voice channels.

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[32] See, e.g., Comments of Southwestern Bell at 13-14; *Southwestern Bell* ***Supplement*** *at* 18. As discussed herein, Pinpoint strongly disagrees with Southwestern Bell's approach to inject increased competition in the provision of AVM a8 it would still artificially limit the number of competitor8 and forego the capacity and performance benefit8 of bandwidths in excess of 4 MHz.

[33] *PacTel a parte* at 2.

[34] *The* ***PacTel*** *a* ***parte*** apparently suggests *that* housekeeping functions of one system would occur during mobile transmissions of another system. ***Id.***, attachment at *(2).* Under Pinpoint's conception Of time sharing, a system's housekeeping functions would occur during the time it alone had access to the spectrum. A8 Pinpoint'8 recently submitted experimental report demonstrates, housekeeping functions account for one percent or less of transmission time, such that sharing by multiple systems will not cause an appreciable decrease in overall AVM capacity in the band under time sharing. See Hatfield Associates, Inc. "Review and Discussion of the Pinpoint ARRAY"' Network and Its Performance," at 4-4 to 4-6, filed as au a *pane* presentation in PR Docket No. 93-61 on January 24, 1994 ("Hatfield Report").

A very conservative 25 kHz channel spacing[35] in Pinpoint's proposed narrowband forward link sub-bands would allow at least ten forward link control channels and ten emergency voice channels.[36]

The Commission could hardly justify keeping Pinpoint or other operators out of a market under a time sharing scheme on the basis of "insufficient forward links" in the 902-928 MHz band plan. As Pinpoint has explained on several occasions, it, for one, does not require access to such forward links at all, as it conducts its "forward link" operations in the same bandwidth used for vehicle location.[37] Moreover, as explained above, Pinpoint believes that PacTel's proposal could be modified to accommodate a considerable number of forward link operations in the band. None of the AVM systems requiring forward links currently is using more than one or two 25 kHz channels for control functions. In addition, there is no reason that other private radio spectrum already allocated by the Commission outside 902-928 MHz could not be used to support forward link operations, particularly because the PacTel system design, as well as the designs of other wide-area proponents, appear to implement the forward links as separate radio system links.[38]

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[35] Modern voice radios already exist for 12.5 kHz channel spacing, and much work has already been done for 5 and 6.25 kHz channel radios.

[36] If the voice channels are shared on a trunked basis, there would be more capacity available in a market for emergency communications than on many individual trunked SMR systems. See discussion in Section IV *infra regarding* voice operations in the AVM band.

[37] Pinpoint Comments at 21-22.

[38] The PacTel system uses forward links that appear very analogous to paging signals. There are a total of 80 paging channels available at 929 and 931 MHz. Moreover, an additional 3 MHz of spectrum (continued...)

Finally, and most antithetical to a band plan promoting vigorous competition, PacTel now suggests that wide-area systems each be granted ***exclusive access to*** a ***wideband*** forward link of 1.5 MHz bandwidth. To effectuate this component of its proposal, PacTel would provide that only 6.5 MHz of the 10 MHz wide-area system sub-band (904-910.5 MHz) could be time shared and only by two systems. Pinpoint seriously questions the need for so much spectrum per system to be dedicated for forward (data)[39] links in the 902-928 MHz band.

As Pinpoint's system design demonstrates, wideband forward links can be easily accommodated on a time shared basis in the same spectrum band in which mobiles emit their wideband pulses for vehicle location. In contrast with PacTel's wideband forward links, which would artificially restrict the number of competitors, Pinpoint's wideband "forward links" do not operate to restrict entry. Rather, Pinpoint integrates vehicle location and data messaging functions, performing them simultaneously on the same signal. Moreover, it is noteworthy that until the ***PacTel ex parte***, PacTel had never indicated any need for wideband forward links, although it discussed the need for

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[38](...continued)
at 901-902, 930-931, and 940-941 MHz, based on 50 kHz channelization, has been made available for narrowband PCS, with which AVM could be integrated. *Amendment of the Commission's* ***Rules*** *to Establish New Narrowband Personal Communications* ***Services***, First Report and Order, Gen Docket No. 92-100, FCC 93-329 (released July 23, 1993). Forward links might also be established within Specialized Mobile Radio ("SMR") or Expanded SMR spectrum.

[39] Although not clear from *the PacTel* ***ex parte***, it may be that PacTel envisions the wide-band forward links to be used for mobile data applications complementing vehicle location. Pinpoint notes that the bandwidths of the forward links are consistent with CDMA cellular work performed by Qualcomm and Hughes.

narrowband forward links on numerous occasions.[40] Similarly, neither MobileVision nor Southwestern Bell has ever indicated a need for separate wide-band forward links.

The PacTel exparte does not adequately explain the need for such links. In fact, the ***ex parte***, in listing the functions that wideband forward links would serve, demonstrates that these activities are also carried out by both the narrowband forward links as well as the time shared spectrum:

- Control station operations are carried out in both the narrowband forward links and the time shared spectrum;
- Mobile non-emergency communications are carried out in the shared wide-band; and
- Emergency voice is carried out in the narrowband forward links.[41]

Accordingly, it would appear that narrowband forward links are sufficient for AVM systems that do not carry out forward link functions in the shared band on a time shared basis, as does Pinpoint.

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[40] **Petition for Rulemaking filed by North American Teletrac and Location Technologies, RM-8013 (filed May 28, 1992) at 21-22; PacTel Comments at 51.**

[41] ***PacTel ex parte*** **attachment at (2). PacTel would also carry out emergency voice in the shared wideband. Pinpoint, as amplified below, strongly believes that voice transmissions should be very limited in the AVM band as a whole, since 902928 MHz is the only spectrum set aside for AVM/LMS and voice transmissions interfere with high-speed vehicle location operations. While such operations should be allowed in this band under specific restraints, the band plan should not allow such transmissions to occur in the time shared wideband where such transmissions could interfere with critical vehicle location communications that support both public and private safety.**

III. SOUTHWESTERN BELL'S ARGUMENTS THATFREQUENCY DIVISION IS THE ONLY FEASIBLE METHOD OF SHARING THE BAND BY WIDE-AREA SYSTEMS AND THAT 4 MHz SYSTEMS WOULD BE IN THE PUBLIC INTEREST ARE SERIOUSLY FLAWED

While Southwestern Bell recognizes the need for rules that accommodate more than two wide-area systems in given geographic market, it continues to offer a decidedly inferior solution to this issue. Specifically, Southwestern Bell seeks the licensing of four 4 MHz systems per market. As Pinpoint showed in its earlier submissions in this proceeding, the more-than-linear increase in throughput -- in both vehicle location as well as data messaging -- as bandwidth increases argues convincingly in favor of a band plan accommodating, but not necessarily requiring, much wider bandwidths than those Southwestern Bell proposes.[42] Nonetheless, Southwestern Bell stubbornly persists that there are no real benefits to be gained from wider bandwidth.

The Southwestern Bell *ex parte Report* demonstrates that Southwestern Bell has almost completely misunderstood the design and operation of Pinpoint's system, which explains in large part its constraining proposals. As a result, Southwestern Bell's generalizations about wide-area AVM system operations just do not apply in Pinpoint's case, and hence they are invalid. First, Pinpoint does *not* employ narrowband forward *links, as the Southwestern Bell* ex *parte Report* states." Rather, high-speed control and application message data pass back and forth between the mobile-radio and base-

[42] See, e.g., Pinpoint Reply Comments at 4647 and n. 116.

[43] *Southwestern Bell ex parte Report* at 4.

stations on a single **wideband** ranging channel in a half-duplex fashion, so that ***no*** separate, wide- or narrowband "forward-link" channel is required.

Second, Southwestern Bell contends in its ***ex parte Report*** that four 4 MHz systems will have no less total throughput than four systems time sharing a 16 **MHz band.**[44] However, at the same time, Southwestern Bell concedes that ***vehicle location capacity*** increases supra-linearly with bandwidth." This concession is of extreme importance because some of the factors that cause the supra-linear increase in location throughput as bandwidth increases, when using modem radar-like spread spectrum modulation and demodulation techniques, incidentally yield a more-than-linear increase in messaging throughput as well.[46] In the Pinpoint system, this is made possible because the ARRAY'" network uses a modem radar-like spread spectrum signaling (modulation/de-modulation) technology that is simultaneously suitable for both **high-**speed radiolocation and high-speed data communication in a communication environment exhibiting severe multipath distortion that is typical of 900 MHz mobile radio. In other words, vehicle location and data messaging functions are performed ***simultaneously*** on the single wide-band messaging/control signal without the need for separate, exclusive forward links.

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[44] ***Id.*** **at 8. ("[T]here is no disadvantage from subdividing this bandwidth for different systems. ")**

[45] ***Id.*** **at 2, 8.**

[46] **For a detailed discussion of this characteristic of practical AVM systems, see the attached Technical Exhibit.**

While all the throughput limiting principles about throughput capacities to which the *Southwestern* ***Bell*** *exparte* ***Report*** refers (Shannon, Cramer-Rao and others) apply to AVM operation at 900 MHz, in most cases, the practical limitations of real system design and operation make those limits only applicable under very limited, and rather "idealized" conditions. Most of the time, a system's performance is reduced well below the values predicted. As a result, the network's messaging capacity is typically very much less than the "theoretically predicted" throughput based on signal-to-noise ratio and occupied bandwidth alone. As a general matter, as Pinpoint explains in the attached Technical Exhibit, the adverse effects from the very limited system design choices available at small bandwidths diminish as occupied bandwidth increases, and data throughput effectively grows faster than the increase in bandwidth. In reality, therefore, while the throughput does not exceed the limits predicted by Shannon *et* ***al.***, as bandwidth increases, it approaches such a ceiling.

In short, therefore, the Commission should not divide the wide-area spectrum into four 4 MHz channels. In order to maximize the potential public benefits of the 902-928 MHz band for AVM, the entire band should be time shared, with as limited allowances for narrowband forward links as possible.

IV. VOICE OPERATION IN THE 902-928 MHz BAND SHOULD BE TRULY INCIDENTAL TO AVM OPERATIONS AND SHOULD NOT DRIVE THE BAND PLAN ADOPTED BY THE FCC

The current AVM rules permit voice operations on a basis related to vehicle location.[47] Pinpoint recognizes that provision for limited voice operations may similarly be made in the final rules for AVM/LMS. However, the 902-928 MHz band represents the only private radio spectrum within which sufficient contiguous spectrum exists to implement high-speed, wide-area radiolocation and complementary high capacity vehicular data information systems needed to support the development of intelligent vehicle highway systems. Accordingly, the final rules should place a clear primary emphasis on vehicle location; and, if the Commission authorizes voice, it should play a purely auxiliary and limited role, as proposed in the *NPRM*, and be relegated to a small sub-band of the AVM spectrum.[48]

The Commission has already set aside numerous bands for established services that could be used for voice in conjunction with AVM. These include common carrier cellular radio, personal communications services, and private voice radio, including conventional and trunked radio, and SMR operations. There is no need to compromise the unique ability of the 902-928 MHz band to support high-capacity, competitive AVM in order to create yet another band in which such voice operations could be located. This is particularly the case as any voice operations, even if set up in the 902-

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[47] 47 C.F.R. 90.239(a).

[48] 8 FCC Rcd at 2503 (LMS will use non-voice signalling methods but will permit "status and instructional messages" related to the units involved).